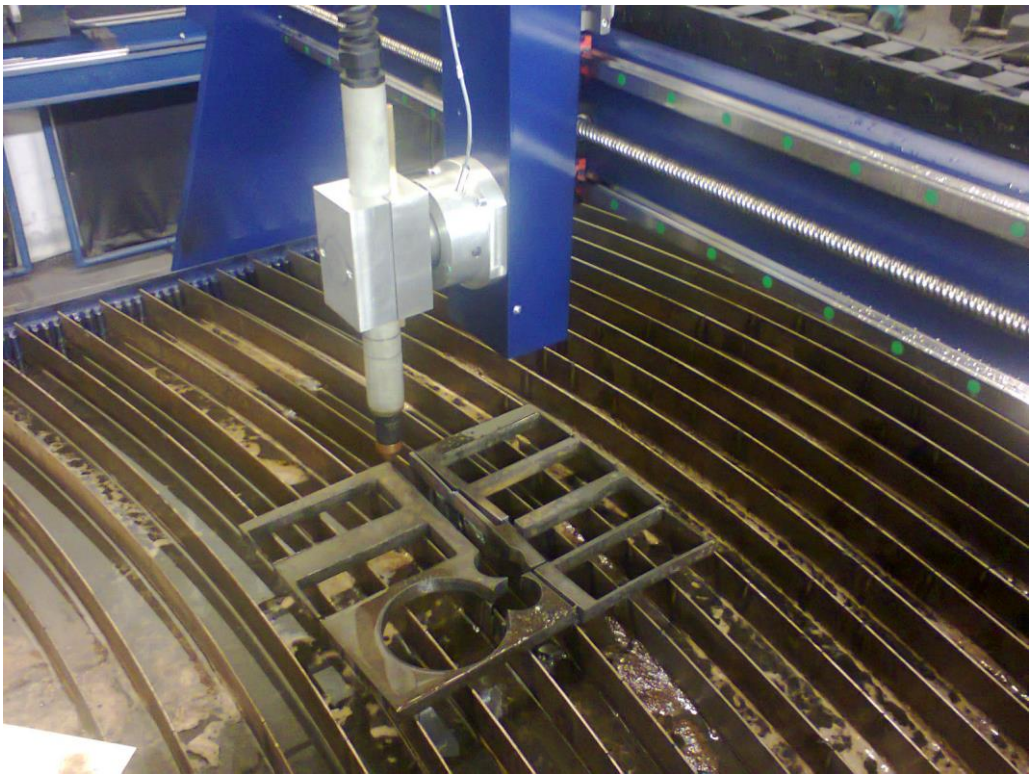
# USBCNC PLASMA CONTROL with iCNC600

PLASMA USERMANUAL



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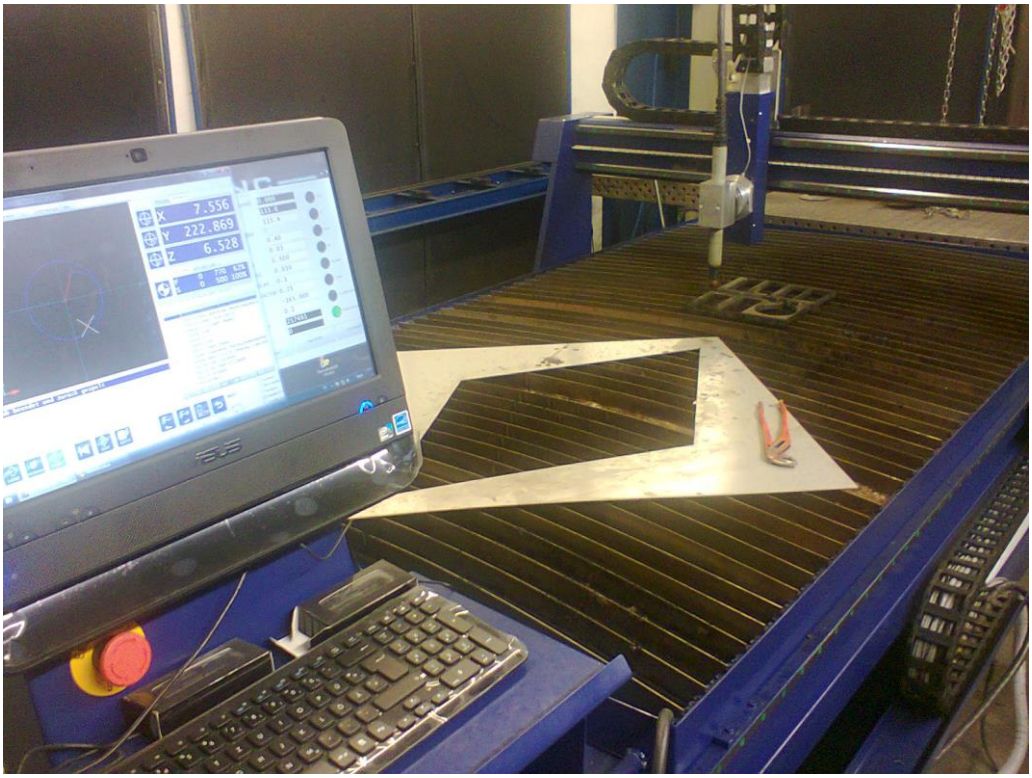
# 1 Introduction

## 1.1 CONTEXT AND SCOPE




**http://www.maschinen-werkzeuge.com/**

**Hyperterm powermax 105**

## 1.2 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| CNC | Computerized Numerical Control |
| CPU | Central Processor Unit, a PCB board with a Processor on it. |
| DXF | Drawing Exchange Format) is a CAD data file format developed by Autodesk |
| FIFO | First In First Out Buffer |
| HPGL | Hewlet Packard Graphical Language |
| GUI/UI | Graphical User Interface |
| INTERPRETER | A software function that is able to read a text file and execute the commands contained therein. |
| JOBFILE | A *job* is the text file (G code) that will be executed by the interpreter. |
| GUI | Graphical User Interface. |
| PWM | Pulse Width Modulation |
| G-Code | CNC specific language to control the movements and IO of a milling machine. |
| LAF | Look Ahead Feed, advanced motion algorithm that ensures minimal machining time. |
| THC | Torch Height Control |
| | |
| | |

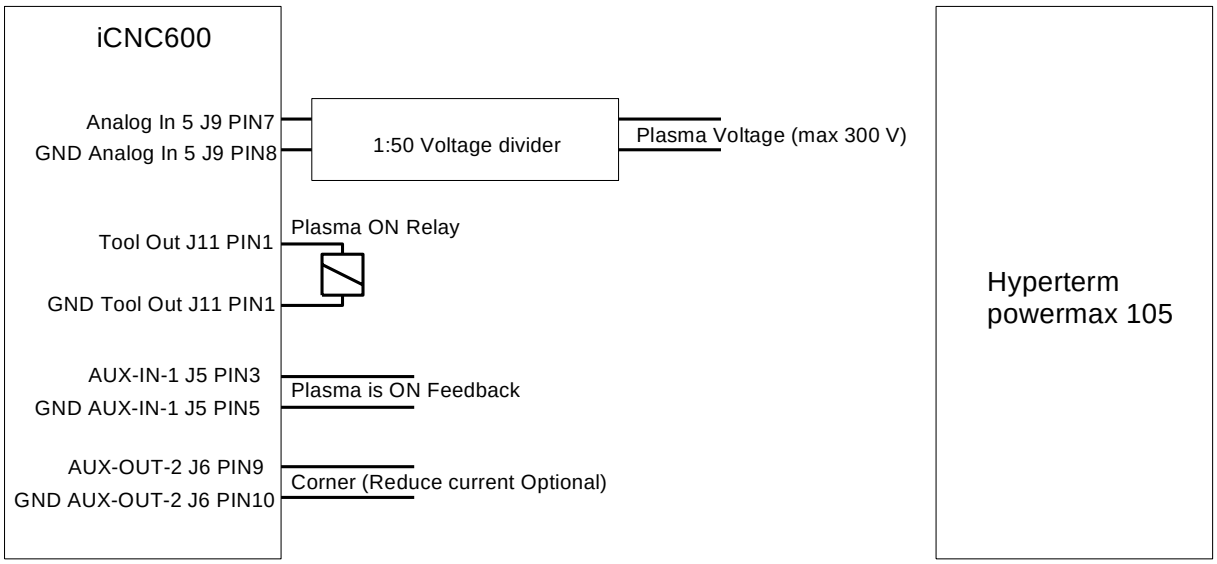
# 2 Torch Height Control

The torch height to the work piece determines the quality of the cutting process. The material to cut is not even in height. The voltage across the torch during the process is coupled to the height of the torch. The higher the torch, the higher the voltage will be.

Since the torch is coupled to the Z-axis of the CNC machine, the voltage can be kept constant by regulating the height of the torch. This can be done by feeding the (attenuated and isolated) torch voltage to the CNC system. This system will control the height of the Z to keep the voltage constant.

## 2.1 INTERFACE PLASMA – CNC

Connections Table PLASMA machine.




The plasma arc signal is used to control the height of the Z axis.
The signal is high voltage (approx. 300V and during ignition even several 1000 volts), it is brought back to a safe voltage using 1 1:50 plasma voltage divider. This divider is already build in into the plasma current source or can be obtained separately from the plasma current source supplier.
The signal from the 1:50 voltage divider is connected to analog input 5, see drawing above.
The plasma is started using M3, this switches to tool output ON, this can be connected with a relay to the plasma current source.
The plasma is on is an output from the plasma source to an input of the CPU indicating that the plasma is ON. This input is optional.
The corner output from the CPU is a signal that becomes active when the CNC is reducing velocity in corners. This signal can be used by the plasma source if supported to reduce the plasma current.

THC control sequence

1. At initial position.
2. Move to start position X,Y,Z=pierce height. (Pierce height is equal to ignition height)
3. Switch plasma on (M3)
4. Delay pierce delay.
5. Move Z down to cutting height.
6. Start contour, after Meas/Control delay activate THC controller.
7. Automatically measure voltage and set as set point if required.
8. At end of contour, switch plasma
9. To Retract height.

# 3 Plasma UI

## 3.1 GENERAL SETTINGS FOR PLASMA.

Some items need to be setup in the cnc.ini, use notepad or notepad++ similar program to edit the file. This is an example of a working setup:

[PLASMA]
defaultSetPointVoltage = 135.000000
KPUp = 0.600000
KPDown = 0.600000
KD = 0.050000
deadBand = 0.500000
filterTime = 0.050000
holeDetectVoltage = 25.000000
holeDetectTime = 0.100000
controlDelay = 0.100000
cornerFeedFactor = 0.250000
zMax = 0.000000
zMin = -167.000000
adcOffset = 60.000000
adcMulFactor = 0.1400000
plasmaIsOnInputPortID = 0
plasmaIsCornerOutputPortID = 0
plasmaZDownInputPortID = 0
plasmaZUPInputPortID = 0
plasmaAnalogInputPortID = 5
measuredIsSetpoint = 1

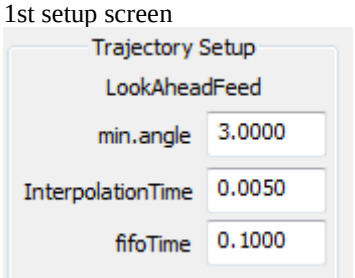
The adcOffset and adcMulfactor determine the relationship between the input voltage read by the processor and the arc voltage. The adcOffset value of 60 resembles the arc voltage where the analog input read is zero. The adcMulFactor is calculated by dividing the range through 1000, in this case, the range 60-200 = 140, so the adcMulFcator = 140/1000 = 0.14.

The plasma THC needs:

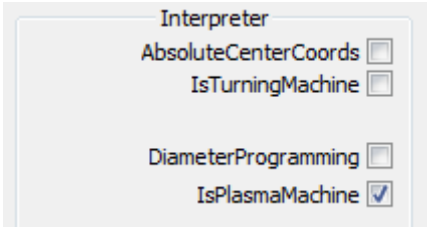
1. The iCNC600 CPU
2. An external 1:50 voltage divider to be obtained from the plasma source supplier, e.g. Hyperterm.
3. PC with reliable and fast Ethernet, because we will reduce the fife time This improves the dynamic of the THC.

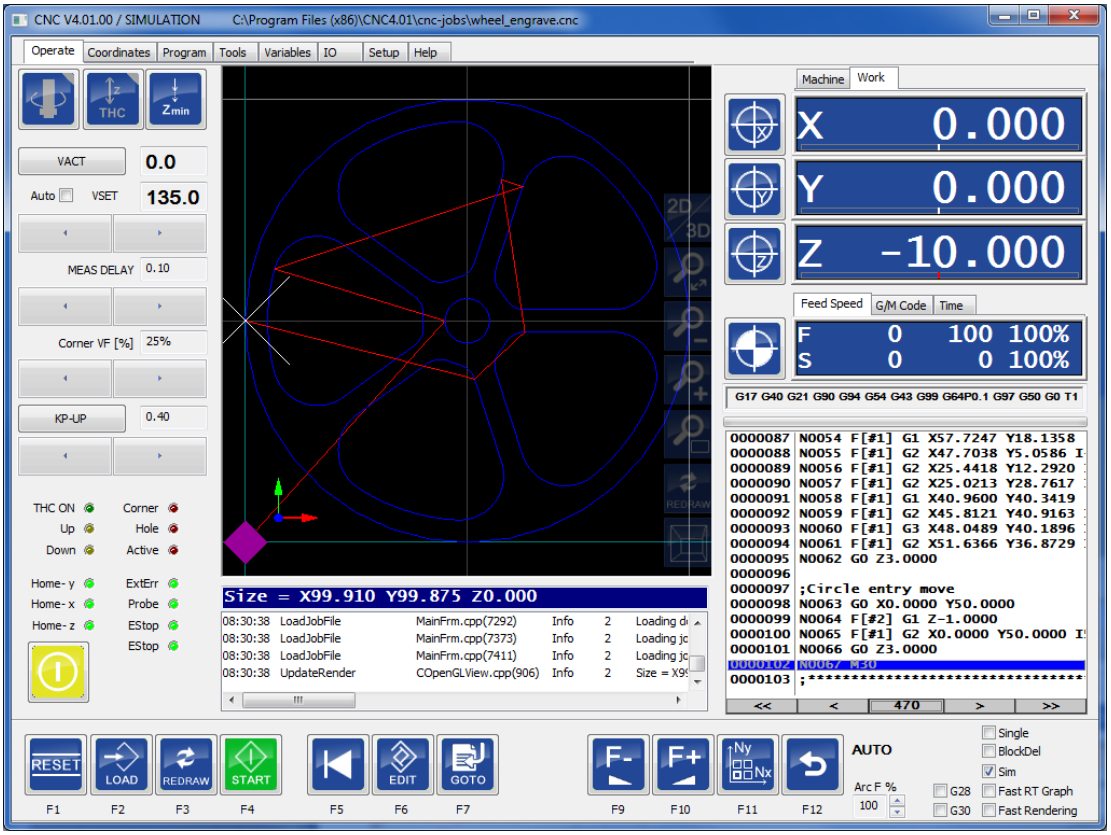
So in the standard setup please set the interpolation Time and fifo Time like this:
(Standard fifo time = 0.2 Second)

1st setup screen



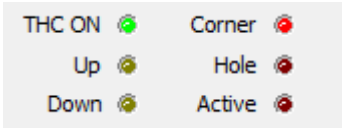

2nd setup screen




Its about the left panel.

## 3.2 THE LEDS




THC ON : LED is ON when THC function is on.
UP: Z is moving UP
Down: Z is moving down
Corner: Corner protect active
Hole: Hole Detect active
Active: On when control is active

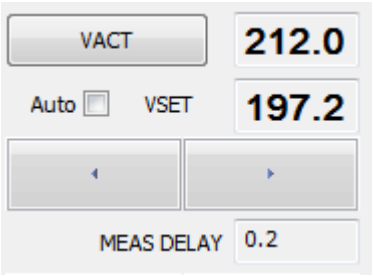
The THC is active when several conditions are met:

- THC function is switch on
- Spindle (PLASMA) is ON
- Move is G1, G2, G3 without Z
- Corner protect is not active
- Hole detect is not active.

## 3.3 AT THE TOP WE SEE 3 BUTTONS:

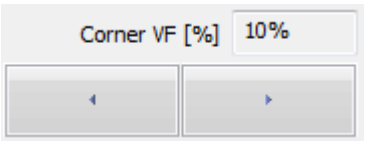
- Spindle ON/OFF (PLASMA) : Switches the plasma ON/OFF
- THC ON/OFF, switches the THC system ON/OFF.
- Define Z min, takes current Z position and define that as minimum for the THC, THC will not go lower. It is displayed also in the Z readout gauge in RED.

## 3.4 VACT AND VSET:




- VACT button allows to switch the display between the actual plasma voltage or the following error, Vactual - Vset.
- Auto, when switched on a automatics measurement will take place at the beginning off the cutting sequence. After the Mesa Delay time delay, the voltage is measured and set at set point. This is performed once for a job.
- VSET shows the actual Voltage setpoint for the THC controller.
- Meas delay: Sets the delay for automatic measurement and control on. When a cutting move starts, this delay is used before the controller is switched on and the measurement is taken.

## 3.5 CORNER PROTECTION




The Corner VF setting is needed to prevent the torch from diving down at corners.
At corners the actual Feed becomes lower, because of this the Plasma voltage gets higher and the THC will start moving the Z DOWN. This is not wanted. So when the Feed is lower than specified percentage here, the THC control will temporarily be disabled, the Z axis will remain at same height.

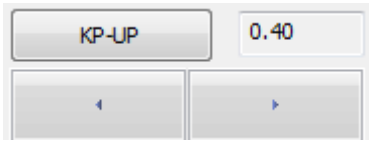
## 3.6 CONTROLLER PARAMETER SETTINGS

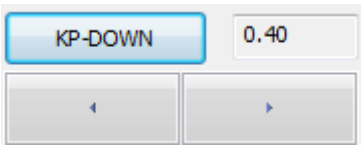
There are a few control parameters, which can be set here, by pressing the button that now showsd KP, next parameter becomes visible to be set.

**Default parameters**

| FIFO TIME | KP | KD | DB | FILTER | HOLE D. V | HOLE D. T |
|---|---|---|---|---|---|---|
| 0.2 (standard) | 0.3 | 0.04 | 0.5 | 0.05 | 25 | 0.1 |
| 0.1 | 0.6 | 0.02 | 0.5 | 0.05 | 25 | 0.1 |

### 3.6.1 KP



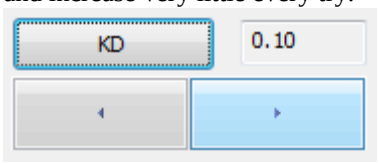




Standard the KP parameter is shown, this controls the THC control speed. When to low, the Z axis will follow too slow. When too high, the Z axis will start oscillating.

There are 2 KP values, one for moving UP and one for moving down. We have made this because experience learns that that the behavior of the system is different moving up or down.

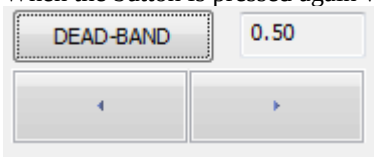
### 3.6.2 KD

When the button shown KP is pressed we will see KD, this is the differential K factor for the control loop. It makes the dynamic better, but it easily makes the control loop oscillate. Start wit low values and increase very little every try.



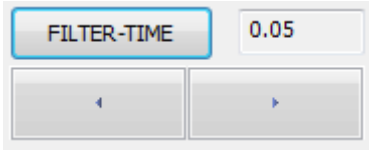

### 3.6.3 DEADBAND

When the button is pressed again we see the DEADBAND parameter.




When VACT-VSET is lower than this value, the controller does nothing, it prevents limit cycling, going up down continuously when not needed.

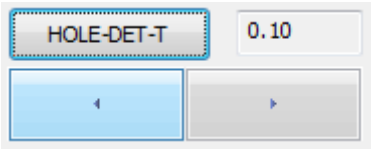
### 3.6.4 Spike filter




Next parameter is FILTER-TIME
This is the time of our spike filter, spikes are filtered as well sudden voltage increases when going over a part where there is already cut.
Suppose we are moving with F3000, and our cutting width is 2 mm.
F3000 = 50 mm/sec or 2 millimeter takes 0.40 sec. The filter time should be bigger than 0.04 to filter this spike away. Be Aware, the filter influences the control speed negatively.

### 3.6.5 Hole Detect

When we go over a hole or when we pass the end of the plate, then the plasma voltage will suddenly rise a lot. When we would do nothing the controller will make the Z move downwards, fast and cause collision. The prevent this we have the hole detection that needs 2 parameters.




When the voltage difference Vact - Vset is more than the HOLE-DETECT-VOLTAGE and longer than the HOLE-DETECT-TIME, the controller will stop controlling.

### 3.6.6 Tracing for checking the behavior

For test purpose an extra parameter is added, LOG AN INPUT VAL, this value can be 0 or 1. When set to 1, the values of the analog value are logged to a file for investing. The file is made in the CNC4.01 director and gas this format: ANALOG-MM-DD-YYYY-HH-MM-SS.txt.
The tracing performs its function during 1 run, then it is switched off automatically, so you need to switch it on again for every run you want to use it.
It can be easily shown with GNUPLOT, like this.

Start GNUPLOT:
In the console type e.g.

gnuplot> cd c:\program files\cnc4.01
gnuplot> 'ANALOG-32-1-2013--21-3-32.txt' u 1:2 w l
It means to plot the data in the file of Column 1 as X and Column 2 as Y with lines connected.
This is the result of random changing the analog input: